U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 215.

ALFALFA GROWING.

BY

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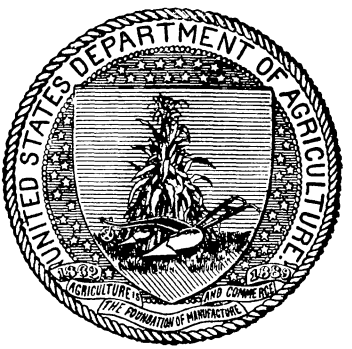

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., January 26, 1905.

SIR: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin, to replace Bulletin No. 31, Alfalfa or Lucern, the manuscript of an article on Alfalfa Growing prepared by Mr. A. S. Hitchcock, of the Office of Grass and Forage Plant Investigations of this Bureau, under the direction of the Agrostologist in Charge.

The successful cultivation of this crop by individual farmers in almost every State in the Union, together with the attention it has received in the agricultural press and in the publications and correspondence of the Department of Agriculture and the State experiment stations, has created remarkable interest in alfalfa growing in the Eastern States, where until recently this crop has been grown on a field scale in only a few localities. The cultivation of alfalfa is perhaps spreading more rapidly at the present time than is the case with any other crop in the country, and the demand for information concerning it is correspondingly urgent. This bulletin has been prepared to meet this demand. Special effort has been made to secure data applicable to the Eastern and Southern States, where experience with the crop is most limited.

In the preparation of this bulletin much valuable information has been secured from the various State experiment stations and from farmers all over the country who have had experience with alfalfa growing.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ALFALFA GROWING.

HISTORY.

Alfalfa (*Medicago sativa*) has been cultivated as a forage plant for more than twenty centuries. It is a native of western Asia, was cultivated by the ancient Greeks and Romans, and its cultivation has been maintained in the Mediterranean region down to the present time. From Spain it was introduced into Mexico at the time of the Spanish invasion and thence to the west coast of South America, and in 1854 to California. It rapidly spread over the irrigated districts of the western half of the United States, where it is now cultivated almost to the exclusion of other forage plants; but success was obtained in the eastern half of the United States in a few localities only, such as central New York; Carver County, Minn.; southern Michigan; Lake County, Ill.; and Hamilton County, Ohio.

NAME OF PLANT.

The Arabic name "alfalfa" is the one by which the plant has been known in Spain, and this name accompanied the plant when it was carried to Mexico and the western United States. The plant is now generally known in this country under the name alfalfa, although it is called lucern (lucerne, or luzerne) in central Europe and in certain portions of the United States, where it was locally introduced from central Europe. It is also called lucern in Utah and adjacent parts of Idaho and Wyoming, where the name is pronounced with the accent on the first syllable.

DESCRIPTION OF THE PLANT.

Alfalfa is an upright, perennial plant, somewhat resembling red clover, but the purple flowers are in a long cluster rather than in a compact head. These clusters are scattered all over the plant instead of being borne on the upper branches, as in clover. The pods and seeds are shown in figures 1 and 2.

The plant has a long taproot, which descends to a great depth where the soil permits. At the surface of the soil is soon formed a strong crown from which spring the new stems, as shown in figure 3.

Young plants of sweet clover (*Melilotus alba*) closely resemble alfalfa, for which they are often mistaken. In later stages the sweet clover is easily distinguished by its tall growth, biennial habit, and white flowers. A seedling plant of alfalfa is shown in figure 4.

FIG. 1.—Alfalfa; *a*, *b*, seed pod; *c*, seed.

TURKESTAN ALFALFA.

A few years ago the Department of Agriculture imported from northern Turkestan a variety of alfalfa, which was distributed for trial to several experiment stations and a number of individual growers in various parts of the United States. This alfalfa, now generally known as Turkestan alfalfa, was found growing in semi-arid regions, and showed great resistance to drought. The results of the experiments in this country show that it is somewhat more resistant to drought than the kinds already grown, and is probably better adapted than the ordinary kind to dry regions where alfalfa must be grown without irrigation. The Department is unable to supply more seed of this variety, as the original importation is exhausted. Several seedsmen advertise Turkestan alfalfa, but the seed that is advertised has not been given comparative tests to determine its value. Such value depends largely upon the part of Turkestan from which the seed is obtained; for Turkestan is a large country and not all the alfalfa grown there is of a particularly drought-resistant sort.

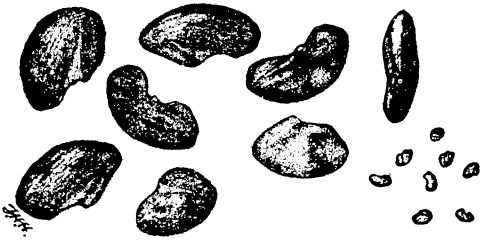

FIG. 2.—Alfalfa seed (*Medicago sativa*).

DISTRIBUTION AND AMOUNT OF CROP.

The distribution of the alfalfa crop for 1899, shown upon the map, figure 5, was compiled from the reports of the Twelfth Census, and was prepared by placing in each county of the United States one dot for each thousand acres grown in that county. Since 1899 the acreage east of the Mississippi River has considerably increased.

ACREAGE AND YIELD.

The following figures are taken from the report of the Twelfth Census, which gives the statistics on alfalfa for 1899, the most recent available for the entire country. There were 96,114 farms reporting an acreage of 2,094,011, upon which was produced 5,220,671 tons of alfalfa hay, an average yield of nearly 2.5 tons per acre.

Alfalfa production in United States in 1899.

Divisions.	Acres.	Tons.	Average yield per acre.
North Atlantic division	6,236	13,776	2.2
South Atlantic division	1,087	1,618	1.5
North Central division	415,556	936,130	2.3
South Central division	41,537	74,875	1.8
Western division	1,629,595	4,194,272	2.6
Total	2,094,011	5,220,671	[a]2.5

[a] General average.

The six States having over 100,000 acres of alfalfa, given in the order of acreage and yield, are as follows:

States producing most alfalfa.

States.	Acres.	Tons.	Average yield.
Colorado	455,237	1,107,471	2.2
California	298,898	838,730	2.8
Utah	268,229	681,515	2.5
Kansas	267,376	601,624	2.2
Idaho	160,029	425,706	2.6
Nebraska	115,142	275,334	2.4

The highest average yield reported for any one State is that of Washington, which has an acreage of 35,166, with an average yield of 3.4 tons per acre.

The larger part of the alfalfa crop is grown in the western division, especially in the arid regions where irrigation water can be supplied. There are many localities in the arid and semiarid regions where the local conditions are such that alfalfa may be grown without irrigation, but the amount thus cultivated is relatively unimportant.

ALFALFA IN THE GREAT PLAINS.

The necessity for a leguminous hay crop in the Great Plains region just west of where red clover could be successfully grown early drew the attention of farmers there to alfalfa, which was already cultivated in the irrigated valleys lying east of the Rocky Mountains. At first the efforts to grow this plant upon the uplands were but partially successful. It was found necessary to give particular attention to the preparation of the soil for the seed bed. At the present time alfalfa is grown on the uplands without irrigation, in Texas, Oklahoma, Kansas, and central Nebraska, as far west as the one hundredth meridian. The range of successful culture is being gradually extended northward in this belt, and doubtless by means of northern-grown seed alfalfa may ultimately be pushed to the Canadian line.

FIG. 3.—Alfalfa, 3 years old.

Indeed, this crop is now grown with fair success at the experiment stations at Brandon, Manitoba, and Indian Head, Assiniboia, and at various places in British Columbia and Alberta.

ALFALFA IN THE EASTERN STATES.

Although alfalfa has been grown for a long time on a small scale in many localities in the Eastern States, it is only within a few years that serious attempts have been made to extend its culture and place it among the important forage crops of this region. Alfalfa is now being grown successfully on a field scale in the alluvial black bottom lands of the Red River in Louisiana, the Mississippi River from southern Missouri to New Orleans, the Yazoo delta in Mississippi, the black prai-

rie belt of Mississippi and Alabama, the bluegrass region extending from Tennessee to New York and Iowa, and various isolated but favorable localities elsewhere. The attempts to grow alfalfa in New England have been successful in but comparatively few cases. The fact, however, that in some cases these attempts have been followed by success shows that the alfalfa area in this region may be appreciably extended when the conditions required for its growth are better known. Every year sees an extension northward of the alfalfa area in Minnesota, Wisconsin, and New York. A particularly hardy strain has been grown in Carver County, Minn., for a number of years. The Minnesota Experiment Station has found that the seed from this strain gives satisfactory results, and confirms the statement that alfalfa can be acclimatized in regions much farther north than where it is now commonly grown. Alfalfa is a standard forage crop in the limestone districts of southern Ontario, and is grown here and there as far north as Ottawa and southern Quebec. In Nova Scotia it can be grown, but the soil conditions are unfavorable, and it does not compete with red clover.

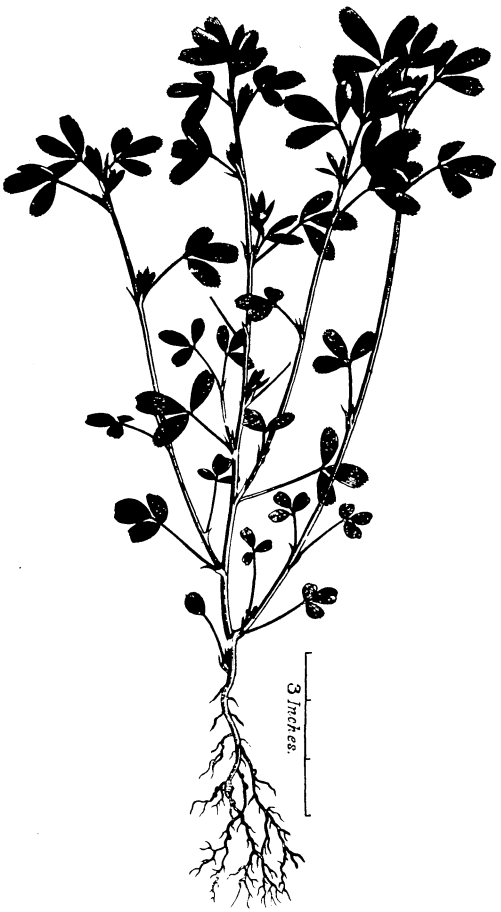

FIG. 4.—Alfalfa seedling, 6 weeks old.

CONDITIONS REQUIRED BY ALFALFA.

CLIMATE.

In mountain regions alfalfa growing is limited at high altitudes by the low winter temperature and also by the low mean summer temperature, the limit varying from 3,000 feet in the north to about 8,000 feet in the south. Along the northern border alfalfa culture is lim-

ited by the low winter temperature. Northern-grown seed is more hardy than southern-grown seed, and by gradual acclimatization the limit of the alfalfa belt will be gradually pushed northward. This result may be aided by the introduction from the Old World of strains already accustomed to a cold climate, as has been illustrated by the importation some years ago by this Department of a variety from northern Turkestan known as Turkestan alfalfa, which showed itself better adapted to dry regions than the strains already grown in this country. But other conditions modify the effect of the winter season. Alternate freezing and thawing tend to loosen the growing plants and heave them out. This action is not so likely to take place on an old field where the plants are well rooted. Where the soil is cold and wet in

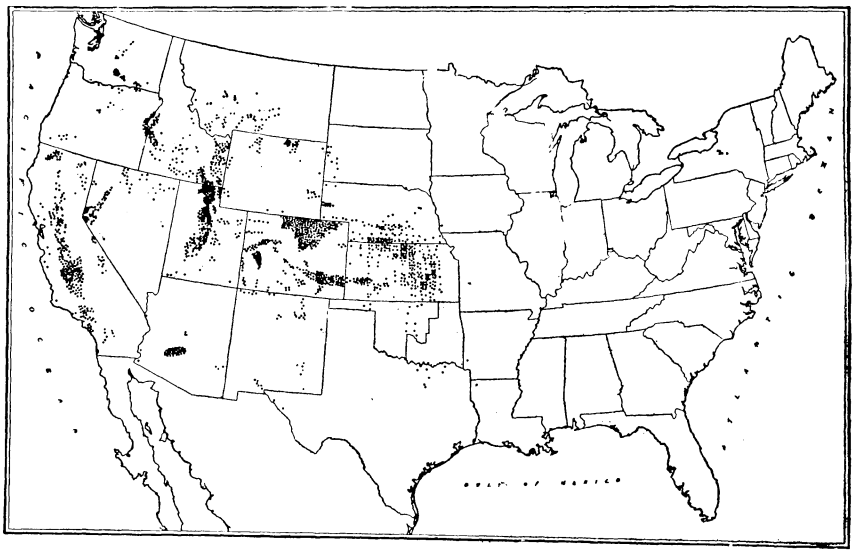

FIG. 5.—Map showing distribution of alfalfa in the United States in 1899. Each dot represents 1,000 acres.

the spring, as is usually the case in New England, the growth of alfalfa is greatly hindered, and this is given as one of the chief causes of failure by experimenters in that region. Good drainage and improvement of the texture of the soil will aid in preventing such failures.

Although a well-set alfalfa field will withstand considerable drought, yet the growing of alfalfa is limited by insufficient rainfall unless water can be supplied by irrigation. In general, alfalfa requires about 20 inches annual rainfall. In the southern portion of the United States more than this is necessary, and in the North, on account of the cooler climate, a less amount may be sufficient. Much also depends upon the distribution of the rainfall, the water-holding capacity of the soil, the depth to permanent moisture, the presence of seepage water from neighboring slopes, and other local or climatic conditions which affect

the evaporation or the available water supply through the growing season, so that it is impossible to state the necessary rainfall in other than an approximate manner.

SOIL.

Favorable conditions.—Alfalfa grows best in a well-drained, loamy soil with a subsoil sufficiently open to allow the roots to penetrate to a considerable depth; yet an examination of the soil in the various alfalfa districts shows that there is a much wider variation in the soil conditions than has been generally supposed. In the irrigated regions the soil is usually adapted to the growth of alfalfa and little difficulty is experienced in obtaining successful stands. However, like other plants, alfalfa suffers if, from improper methods of irrigation, the soil becomes too strongly impregnated with alkali. Old alfalfa fields may apparently withstand considerable quantities of alkali, because the deep-seated roots may be drawing their supply of water from lower strata, where there is less alkali.

Effect of alkali.—The relation of alfalfa to alkali soil has been investigated by the California Experiment Station. It was found that the tolerance of salt solutions in the soil by young alfalfa plants is about as follows, which represents the amount of alkali in an acre of soil for the upper 2 feet: Sodium carbonate, 1,200 pounds; sodium chloride, 750 pounds; sodium sulphate, 1,200 pounds. Well-established plants are able to withstand a much larger proportion of mineral salts. An old alfalfa field in good condition was examined, in which the alkali present in the upper 6 feet of an acre was: Sodium carbonate, 3,000 pounds; sodium chloride, 6,000 pounds; sodium sulphate, 102,000 pounds. In such old fields the plants shade the soil and prevent the surface evaporation which tends to bring the alkali upward. If alfalfa is to be sown upon alkali soil, the alkali should be first leached downward by one or, if necessary, two thorough irrigations before planting. With the alkali, or at least the excess of it, kept below 5 or 6 feet by proper irrigation the alfalfa will thrive.

Acidity of soils and other unfavorable conditions.—In the eastern half of the United States, where irrigation is seldom practiced with this crop, the character of the soil is directly or indirectly closely related to the successful cultivation of alfalfa. The Missouri Experiment Station has shown that an acid soil is unfavorable to this crop, a fact which has been corroborated by the experience of growers in the East. This unfavorable condition can be corrected by the application of lime, the amount depending upon the degree of acidity. It may be in any given case that the unfavorable factor is not the acidity of the soil, but compact texture, lack of aeration, or some other condition which is corrected by the incorporation of lime or the accompanying tillage.

Heavy clay.—In the Southwest, as in Arizona, where the soil never freezes and all moisture must be supplied by irrigation, and the fields are often pastured, alfalfa can not be successfully grown on heavy clay soils. Farther north in the irrigated district, where the soils freeze deeply or where the rainfall is sufficient to start the young alfalfa, it can be successfully grown on heavy clay soils. In the irrigated alfalfa regions temperature conditions, rainfall, and pasturage are all important in determining the suitability of a soil for this crop.

Excess of water.—An excess of water in the soil is a very unfavorable condition for alfalfa. Where the water level is near the surface, or where the surface water from heavy rains is unable to drain off rapidly, alfalfa usually fails. For this reason an alfalfa field is injured by being submerged from an overflow, or even killed if the water remains over the surface for too long a period. Experience has shown that when covered by clear running water the injury is much less than when a sediment is deposited or the water is stagnant. Ordinarily alfalfa will not withstand an overflow of more than a few days. Flooding in the winter is less injurious than during the growing season. On irrigated fields injury often follows from the accumulation of water in depressions after a flooding. The alfalfa is killed out in these spots and noxious weeds gain a foothold.

Nature of subsoil.—It is generally stated that alfalfa requires a porous subsoil, but this statement must be modified. If the subsoil is near the surface and is of such a nature as to prevent the entrance of the alfalfa roots, alfalfa will probably fail; but many of the so-called impervious subsoils allow the roots to penetrate. The effect of the subsoil seems to depend on how it affects drainage and upon the texture and fertility of the surface soil. The reports of successful alfalfa fields upon subsoils of gumbo, hardpan, and stiff clay are too numerous to disregard. Near Syracuse, N. Y., there is an alfalfa field growing upon a rocky hill where the coating of soil is only 2 to 4 inches in depth. The success under such apparently adverse conditions is due to the fact that the roots are able to penetrate the numerous vertical cracks in the rock.

Need of fertility.—An important condition and one which is likely to be lacking in many of the worn-out eastern soils is fertility. It is very essential that the soil be in the condition usually described as fertile. This refers not only to the presence of the required mineral elements but to humus and to a favorable texture. It is not worth while attempting to grow alfalfa upon sterile soil. Such soil should be enriched by the addition of barnyard manure or other fertilizer or by the plowing under of leguminous crops. Compact, cold, or wet soil is unfavorable to the growth of alfalfa, and such soil should be drained and thoroughly aerated by cultivation to reduce it to the proper text-

ure. Sandy soil is usually not well adapted to alfalfa, partly because it may be sterile, lacking in humus, or too loose in texture. If a stand is once obtained the crop may not suffer from lack of moisture, as there is usually a water supply below the surface. In the Southern States sandy soil is so favorable to the growth of crab grass and other weeds

FIG. 6.—Nodules of nitrogen-fixing bacteria on the roots of alfalfa.

that alfalfa is soon choked out. In general, it is well to prepare sandy soil by incorporating humus and fertilizing and by suitable culture to free from weeds.

NITROGEN-GATHERING NODULES.

It is well known that alfalfa, in common with other legumes, has upon its roots nodules or tubercles (fig. 6) produced by certain bacteria with whose aid the plants are enabled to obtain a supply of atmospheric nitrogen. By the decay of these nodules the soil

becomes richer in nitrogen. Though alfalfa can grow without the presence of these bacteria, especially if the soil is rich and there is an abundant supply of nitrogen; yet under normal field conditions the growth is much more vigorous when these organisms are present, as indicated by the nodules upon the roots. The seedling plants are infected or inoculated from the soil if the organisms are present. Where these are not already present it is necessary to inoculate the plants artificially in order to produce the best results. This can be done by scattering upon the field soil from an infected field or by placing the bacteria directly upon the seed before sowing. The latter procedure has been rendered practicable by the use of pure cultures, a method perfected in the Laboratory of Plant Physiology of the Bureau of Plant Industry of the Department of Agriculture.

Throughout the region west of the Mississippi River and a considerable portion of the Eastern States this organism seems to be already widely spread in the soil. At the Illinois Experiment Station it has been shown that the organism upon the roots of the sweet or Bokhara clover (*Melilotus alba*) produces the same effect upon alfalfa as the alfalfa organism itself. Since this plant is widely introduced as a weed in most of the region east of the Rocky Mountains, the chances are good for natural inoculation in many cases. Experiments at the North Carolina Experiment Station seem to show that the same organisms occur upon the roots of bur clover. Nevertheless the natural inoculation upon the first crop may not be sufficient for its needs. This appears to be shown by the fact that better results are likely to follow successive sowings upon the same land. But in any case it must be borne in mind that artificial inoculation of the seed will supply only one of the necessary conditions and will not prevent failure from other causes.

A Farmers' Bulletin, No. 214, on this subject (Beneficial Bacteria for Leguminous Crops) can be obtained without cost upon application to the Secretary of Agriculture.

CULTIVATION.

PREPARATION OF THE SOIL.

It is very important that especial attention be given to the preparation of the soil upon which it is proposed to sow alfalfa. Not being provided with creeping roots or stems, the plants will not spread as is the case with such grasses as Kentucky bluegrass or Bermuda grass. The individual plants become larger each year by the increasing size of the crown, but bare spaces in a field will not be filled in except as new seed may be sown. Furthermore, the young alfalfa plant is quite tender and is easily crowded aside or choked out by weeds or checked in its growth by lack of moisture or by other unfavorable conditions.

For these reasons it is highly desirable that a perfect stand be obtained by the original seeding.

Supply of plant food.—The soil conditions required for the best growth of alfalfa have already been pointed out. Assuming these conditions, it is still necessary that the soil should be fairly free from weeds, especially such as are known to interfere seriously with alfalfa. In case the soil, from overcropping or natural sterility, is not sufficiently fertile, it will be necessary to add fertilizer in some form. It is, therefore, desirable to commence the preparation of the soil at least a year previous to sowing the alfalfa seed. The preceding crop should be one which requires cultivation such as corn, cotton, or roots. The rotation may be such that if the alfalfa is sown in the fall there is time in the summer to plow the land and allow it to lie fallow. The weeds may then be destroyed as they germinate, by occasional harrowings. Although alfalfa can obtain its supply of nitrogen from the air when the plants are well started, it is necessary that the soil should contain plenty of this element at the time of sowing, in order to start the young plants with a vigorous growth. The fertilizer which will accomplish the purpose most quickly and most satisfactorily is good barnyard manure, free from weed seeds. It is better to apply this to the land at the time of growing the preceding crop, as the manure then has time to decompose and become available. Barnyard manure not only supplies nitrogen and other elements, but it supplies humus to the soil, and thus places it in a better physical condition. In place of supplying the elements of fertility by an application of manure the nitrogen and humus may be supplied by growing a suitable leguminous crop, such as red clover or Canada field peas in the North, cowpeas or soy beans in the South. The foregoing may be summed up in the statement that the soil should be fertile and free from weeds.

Plowing and harrowing.—The mechanical preparation of the soil immediately preceding sowing depends much on its condition. For best results the field should be prepared as for a garden. There are localities in the western half of the United States where the soil is of such a nature that plowing is not necessary, especially if the field can be irrigated; but in the Eastern States plowing, thorough harrowing, and the use of the disk, roller, or plank, according to circumstances, is to be advised. Subsoiling has been recommended, but this is usually unnecessary. In the dry regions, where the subsoil is compact, subsoiling will increase the water-holding capacity of the soil. If the soil is wet by rain after being prepared, and is then harrowed as soon as it can be worked, there should result an excellent seed bed to receive the alfalfa.

It is not best to sow alfalfa on freshly plowed land, for a loose seed bed is unfavorable to the young plants. One or two good rains before

seeding improve the condition of the seed bed. It should, of course, be harrowed as soon as in condition after each rain, to keep it from baking before seeding. Alfalfa should not be sown on a field that has just had a green crop turned under. Time should be allowed for the new material to decay and for the acid to be worked out by one or two good rains.

TIME FOR SOWING.

In the Northern States and in the irrigated regions of the West, alfalfa is usually sown in the spring. In the Southern States sowing is generally done in the summer or fall or very early in the spring. As has been pointed out, one of the greatest enemies of young alfalfa is weeds, and spring sown alfalfa is more likely to be choked out during the summer by weedy grasses, such as crab grass, than is that sown in the summer. Toward the northern limit of the alfalfa belt, however, the seasons are shorter and the plants may not be sufficiently started to survive the winter in case the seeding is done in the fall. Furthermore, the time of sowing is likely to be influenced by the rotation of crops practiced upon the farm. Where a spring crop can be grown and removed in time to allow sowing the alfalfa in the summer there is no loss of the use of the soil; but in the far North this does not give the alfalfa sufficient time to prepare for winter. In case alfalfa must be sown in the spring in the Southern States, the sowing should be done as early as possible. Fall sowing frequently fails in the South from untimely drought. In such cases the land may be reseeded in early spring.

SOWING WITH A NURSE CROP.

As a usual thing, at least from the standpoint of the alfalfa crop, it is best to sow the alfalfa alone; but it is customary in many localities to sow with grain. If the conditions are well suited to the growth of alfalfa the stand may not be materially injured, and there is gained the crop of grain; also the weeds are kept down while the alfalfa is getting started. Usually, however, there is a loss of alfalfa, the resulting stand being less satisfactory than when the alfalfa is sown alone. Whether this loss is sufficiently compensated by the grain crop must be decided by the grower. If the crop of alfalfa the second year is as good as if it had been sown alone, the grain crop has been gained where the sowing was done in the spring; but if the stand is injured such a gain would not compensate for this loss, as a poor stand can rarely be improved. A more satisfactory method, where fall sowing is advisable, is to grow the grain crop in the spring and prepare the soil anew for the alfalfa. In the irrigated districts, especially in certain parts of California, barley is commonly used as a nurse crop. Beardless barley has been recommended for use in the Eastern States where a nurse crop is often satisfactory. Whatever

grain is used the sowing should be comparatively light, so as not to smother the alfalfa. If the grain crop threatens to be too heavy it should be mowed for hay.

AMOUNT OF SEED AND METHOD OF SOWING.

The seed may be sown broadcast or with a grain drill. The drill has the advantage of distributing the seed more evenly over the surface than is likely to be the case with hand sowing and of placing the seed at a uniform depth. It has the disadvantage of placing the seed too deep unless special precautions are taken. In dry regions drilling is often an advantage, as it places the seed in contact with moisture. If drilling is employed in moist soil the shoes should barely touch the soil. The seed is then covered sufficiently by the chain, wheel, or other accessory that follows the shoe.

Where alfalfa is sown broadcast it is best to use a mechanical sower, such as a wheelbarrow seeder, as the seed is distributed more evenly. The seed should be well harrowed in, or it may be covered by means of a plank drag.

The amount of seed usually recommended is 20 pounds per acre when sown broadcast, and a less quantity (about 15 pounds) when sown with a drill. If the seed is of good quality, the soil in fine tilth, and the conditions for germination are favorable, less than 20 pounds may suffice. Under exceptional conditions successful stands have been obtained with 5 or 6 pounds. Some growers use more than 20 pounds, even 30 or 35 pounds, but this amount seems excessive, and should be used only when necessary to counteract the effect of poorly prepared soil or other unfavorable conditions. Although a thick stand may be an advantage in choking out weeds, yet for the development and subsequent vigor of the plants, it is better to have a thinner but uniform stand. The individual plants then have room to develop a strong crown with the accompanying extensive root system.

TREATMENT OF AN ALFALFA FIELD THE FIRST SEASON.

During the first season following spring sowing the field should be clipped with a mowing machine at intervals to keep down weeds, if the latter show a tendency to choke out the alfalfa. If this is not necessary and the alfalfa has made a vigorous growth, a light crop of hay may be obtained, or under favorable conditions even a second crop. In those parts of the South where the conditions are favorable fair crops should be obtained the first season after spring sowing. At Uniontown, Ala., three crops have been cut the first season from March seeding. Usually, however, returns can not be expected the first season from spring sowing, without irrigation, except in the South. In irrigated districts one or even two or three crops may be obtained the first season. Some growers pasture during the fall after

seeding. This is not to be recommended as it almost always injures the stand, either by the trampling or the close grazing. When alfalfa is sown in the spring with a nurse crop no attention may be necessary after cutting the grain except to clip the weeds if these become troublesome. In clipping to keep down weeds the cutter bar of the mower should be set high, as the seedling plants are injured by close clipping.

It is very important, particularly in the Northern States, to allow alfalfa to go into winter with a good growth—at least 6 inches high. If cut too late in the fall to grow a good winter covering it is very apt to suffer from winter killing.

If the alfalfa is sown in the fall no attention is likely to be necessary until the following season, when it is, if sown early, in about the same stage of development as that sown the previous spring.

SUBSEQUENT TREATMENT OF ALFALFA FIELD.

Although in most parts of the country alfalfa does not reach its maximum development until the third or fourth season, yet the treatment after the first season is similar from year to year. Alfalfa is primarily a hay crop, although it is used in some localities and under certain conditions for soiling, for silage, for a cover crop in orchards, and for pasturage.

If a good stand is obtained from the original sowing no further treatment should be necessary after the first season except to cut the hay at the proper time. If from any cause the alfalfa should die out in spots, or if the original stand was not uniform, or the field should require rejuvenating after a few years because of the compact sod, the best remedy for any of these difficulties is a thorough disking in the spring, the disks being set so as to split the crowns vertically. Seed may be sown in the bare spots either before disking or after; if sown after, the field should be harrowed. If a field is in bad condition, it is usually best to plow up and reseed. It scarcely ever pays, at least where irrigation is not practiced, to coddle a poor stand of alfalfa. Many growers recommend disking every spring, even when the stand is good, and some have found it a paying practice to disk after each cutting. Such disking will often prevent the encroachment of weeds. In the Eastern States alfalfa fields sometimes suffer a check in their growth, tend to turn yellow, and otherwise show a sickly condition. Oftentimes this condition is accompanied by an attack of the alfalfa rust or spot disease mentioned in a later paragraph. The best remedy for such a condition is to mow the field. The vigorous growth thus induced may overcome the diseased condition.

IRRIGATING ALFALFA.

As has been previously mentioned, the raising of alfalfa by the aid of irrigation is confined to the western half of the United States and

mostly to the arid regions. The irrigation water is usually supplied by ditches or canals which in their turn obtain water from mountain streams. In a few localities, such as southwestern Kansas and southern Texas, irrigation water is obtained from artesian wells. On account of the deleterious effect from standing water it is essential that alfalfa fields should be as nearly level as possible. In California, where the fields are slightly sloping, they are divided into suitable small areas called checks, which are separated by low dikes. The checks at different levels are irrigated separately, thus preventing the accumulation of water upon any given portion for too long a period. Where there is an abundance of water and it can be supplied at will throughout the season, it is customary to irrigate in the spring before sowing the seed; or, in the case of an established alfalfa field, before growth starts and again after each cutting.

It is said, however, that greater yields are obtained if the flooding takes place before the hay is cut, and that in California an extra cutting can in this way be secured. The flooding must be long enough before cutting to allow the field to dry off sufficiently, or injury will be done by the trampling of the horses during mowing. It is thought that there is less injury from scalding when the water is applied before cutting.

Minimum of water.—Where the amount of water is limited a much less quantity than is ordinarily used will produce paying crops. The minimum amount of water to produce a crop of alfalfa and the time at which the water should be applied depend upon the soil and climatic conditions. Upon this point there is little available experimental data. Below are given the results of a series of experiments carried on in 1903, by the Utah Experiment Station in cooperation with the United States Department of Agriculture.

Utah experiment on amount of water required by alfalfa.

AMOUNT OF WATER AND DATE OF APPLICATION.

Date of each irrigation and amount of water applied.								Total of water applied.
First.		Second.		Third.		Fourth.		
	Acre in.		*Acre in.*		*Acre in.*		*Acre in.*	*Acre in.*
June 16	3.360	July 29	3.359					6.719
June 29	5.970	July 29	3.359	Aug. 19	3.359			12.688
June 16	5.070	July 8	5.036	Aug. 6	5.003			15.109
June 29	7.020	July 8	5.036	Aug. 19	5.002			17.058
June 15	5.030	July 3	5.100	Aug. 1	5.036	Aug. 24	5.002	20.168
June 20	6.774	July 8	6.694	Aug. 19	6.682			20.150
July 8	12.490	Aug. 19	12.506					25.002
June 20	8.303	July 6	8.352	Aug. 19	8.362			25.017
June 15	6.320	July 6	6.248	Aug. 1	6.248	Aug. 29	6.250	25.066
June 16	6.250	June 23	4.280	June 30	5.705	July 7	[a] 5.230	61.465
June 23	6.250	July 7	6.220	Aug. 15	6.250	Aug. 31	6.250	24.970
June 16	6.250	July 7	6.220	Aug. 6	6.750	Aug. 31	6.250	25.470
June 23	6.610	July 7	3.720	Aug. 15	3.250	Aug. 31	3.750	17.330
June 16	3.980	July 7	3.720	Aug. 6	3.750	Aug. 31	3.750	15.200

[a] This plat was given 5 inches of water on each of the following dates: July 14, July 22, July 28, August 4, August 17, August 25, August 31, September 8.

Utah experiment on amount of water required by alfalfa—Continued.

DATE OF HARVEST AND YIELD OF HAY.

Date of harvest and yield of hay at each cutting.						Total yield of plat.	Calculated yield per acre.
First.		Second.		Third.			
	Pounds.		*Pounds.*		*Pounds.*	*Pounds.*	*Tons.*
June 26	264	Aug. 12	50½			314½	3.145
June 26	177	Aug. 12	101			278	2.780
June 26	261	Aug. 12	68½			329½	3.295
June 26	204	Aug. 12	108½			312½	3.125
June 26	191	Aug. 12	85½			276½	2.765
June 26	175	Aug. 12	74			249	2.490
June 26	93	Aug. 12	62			155	1.550
June 26	99	Aug. 12	44			143	1.430
June 26	224	Aug. 12	140			364	3.640
June 18	176½	Aug. 10	177½	Oct. 16	120½	474½	6.243
June 18	170½	Aug. 10	136½	Oct. 16	73½	380½	5.017
June 18	147	Aug. 10	141	Oct. 16	61	349	4.598
June 18	105	Aug. 10	112½	Oct. 16	46	263½	3.468
June 18	112½	Aug. 10	106	Oct. 16	35	253½	3.340

It will be observed that the maximum crop was produced by applying plenty of water throughout the growing season. However, it is also to be noted that a much less quantity of water when applied at intervals of three or four weeks produced a fair crop. Fifteen and 17 inches of water applied in this way produced more than half as much as 61 inches applied at frequent intervals. Furthermore, three irrigations of 15 to 17 inches produced about the same results as the same amount applied at four irrigations. In applying irrigation water to fields it is necessary to saturate the soil to a reasonable depth. All the water that drains off beyond the amount required for use is lost to the crop. It is not necessary to apply water again until the crop has removed a large part of the available supply.

ALFALFA FOR HAY.

CUTTING.

Alfalfa should be cut just as it is beginning to bloom. After the beginning of the flowering period the hay deteriorates rapidly in nutritive value. If the field is fairly uniform, the proper stage for cutting is when about one-tenth of the plants have reached the flowering period. (See p. 33.) The number of cuttings varies from two or three in the North, or at high altitudes in the mountains, to as many as ten in the irrigated districts along the southern border from California to Texas. The yield is from 1 to 2 tons per cutting, the first cutting being usually the largest, but the yield per cutting, especially for cuttings after the first, is usually less when there are several cuttings. In the alfalfa regions of the country the aggregate yield of hay is, under favorable conditions, usually from 5 to 8 tons per acre. It is customary in many localities to pasture the fields more or less after the last cutting.

CURING.

In regions where alfalfa is irrigated there is usually no difficulty in curing the hay; but in regions where rains may occur during the haying season, especially in humid regions such as Louisiana, great care is necessary to produce well-cured hay of good color. Rains or even heavy dews spoil the color, changing it from the bright green demanded by the market to a yellow or brown. Discolored hay may not be less nutritious for feed but it is less valuable upon the market. The harvesting should take place with as little handling as possible in order to prevent the shattering of the leaves, which contain a large proportion of the nourishment.

Handling in the field.—The preparation of hay from alfalfa is essentially the same as for any of the grasses, being modified somewhat by its succulent nature, especially in the humid regions. On a commercial scale the cutting is done by mowing machines drawn by from two to four horses. The mowing should be commenced in the morning. In the arid regions the making of hay from alfalfa is a very simple process. The air is so dry that the hay mowed in the morning may be raked and stacked in the afternoon of the same day, but in the more humid climates the difficulties increase. There is more moisture in the air, the green alfalfa is more succulent, and the curing process must extend over a greater length of time. There is additional danger of showers or heavy dews wetting the hay before it is dry enough to place in the stacks or barns. Where the alfalfa is especially succulent the curing process may be hastened by the use of a hay tedder. These machines are now in use in many places along the lower Mississippi and Red River valleys. When the hay is sufficiently dry it is raked into windrows and later thrown into bunches or cocks. In regions where heavy dews prevail and the curing will not be completed on the day that the hay is cut, it is often advantageous to rake the partially cured hay into windrows at night and open them out again the following morning. Another method is to throw the partially cured hay into bunches, especially if there is a threatening rain storm, and to open out these bunches by hand upon the advent of favorable weather. It is often sufficient to throw the partially cured hay into tall narrow cocks, and allow them to remain until the hay is thoroughly cured. Such cocks should be as small as possible in proportion to the height in order that there may be a circulation of air and less danger from heating. In Louisiana it is recommended that such cocks be covered with hay caps in order to protect them from frequent rains.

STACKING.

Throughout the western half of the United States alfalfa hay is commonly stored in stacks in the field. Alfalfa stacks will not shed water as readily as stacks of grass hay. In the arid regions there is little danger from rains during the season of storage, but in humid climates it is necessary to store the hay in barns or else cover the stacks with large tarpaulins, or they may be topped with grass; otherwise the percentage of waste is very large. In any case there is likely to be some waste, for which reason the stacks are made large, thus reducing the proportionate amount of waste. In the alfalfa regions of the West the stacks are as high as the hay can be handled easily and may be 200 feet or more in length. The size of the stack is then limited chiefly by the convenience in bringing the hay from the surrounding field. The hay may be pitched onto wagons, drawn to the stacks, and unloaded by hand or by means of various mechanical devices. The method in most common use, however, for transporting hay from the field to the stack is by using some form of hay sweep or, as it is called in many localities, "go-devil." These hay sweeps consist of a row of long teeth sliding upon the ground and pulled by two to four horses. In more modern forms it rests upon wheels, so that it may be lifted from the ground as soon as its load of hay is gathered. The sweep may gather hay from the windrow or from bunches. It is transported to the stack, where the sweep is disengaged from the load by means of backing away. Certain types of stackers will take hay directly from the sweep and leave it upon the stack. The large stacks commonly used in the West are made possible by the use of hay stackers and derricks, by which means bunches of hay, consisting of several hundred pounds, may be lifted by horsepower to any part of the stack and deposited where desired.

BALING.

As is customary with all kinds of hay requiring transportation, alfalfa is pressed into bales when prepared for the market. The convenience in handling is such that alfalfa is frequently baled for local consumption. The ordinary bales of alfalfa weigh about 100 pounds. The hay for baling must be well cured or there is danger of loss from heating and subsequent spoiling. There are many types of baling presses used, most of them being operated by horsepower. There are still in operation a few hand balers, the bales in such cases usually being somewhat larger than those described. The baled hay for export to Alaska, Hawaii, and other transoceanic points is compressed by the process known as double compression, by means of baling machines operated by electricity or hydraulic power. The hay obtained by loosening the ordinary bale of hay is compressed into square or cylindrical packages of smaller and more compact form than the ordinary

bale. The hydraulic presses used for making the so-called round bales are similar to those used for making the cylindrical bales of cotton. The measurements of the different types of double compressed bales are about as follows: Square bale 15 by 18 by 38 inches, weight 160 pounds; square bale for Alaskan trade 14 by 18 by 26 inches, weight 100 pounds; round bale, 2 feet in diameter, 24 inches long, weight 145 pounds, or 36 inches long, weight 260 pounds.

The saving of space in transit may best be understood by comparing the weight and cubic contents of baled and compressed hay. The ordinary bale of hay occupies 140 to 160 cubic feet per ton, the double compressed square bales 85 feet per ton, the round bales 55 feet per ton. There is an increasing demand for alfalfa hay for export.

PASTURING ALFALFA.

In all the alfalfa districts the fields are used more or less extensively for pasturing various kinds of stock. In the arid regions it is quite a common practice to pasture the fields after the last cutting during a portion of the fall and winter. Alfalfa is undoubtedly a valuable pasture plant, but must be used with some caution to prevent loss from bloating, in the case of cattle or sheep, and to prevent injury to the alfalfa field from trampling or overgrazing. Cattle and sheep will bloat as readily upon green alfalfa as upon clover.

Alfalfa is preeminently adapted to the production of hay, and except in the case of hogs its use as pasture is secondary. Where it is intended to use alfalfa primarily as a pasture plant for cattle, sheep, or horses, better results may be obtained by combining the alfalfa with some grass, such as brome grass in the Northwestern States, or orchard grass in the Northeastern States. The mixture is a more nearly balanced ration, gives a greater variety of feed, and is less likely to cause bloat.

DANGER OF BLOATING.

The cause of bloat is not known nor are the conditions bringing it about entirely understood. The danger of loss from this cause is always present whenever alfalfa is pastured with cattle or sheep. The loss from bloat in regions where alfalfa is regularly pastured is ordinarily small, although in some cases it is said to amount to as much as 5 per cent per annum. This loss is more than offset by the increased gain from pasturing, even for the limited time in the fall when the pasturing usually occurs, unless, of course, the animals are especially valuable. The conditions which usually cause bloat in cattle or sheep when fed upon clover, it is sometimes claimed, do not seem to be identical with those causing bloat when alfalfa is pastured. In some regions it is claimed by stockmen that bloat is more likely to occur when cattle are turned upon wet alfalfa, or when they are turned into a pasture when hungry. In other regions stockmen insist that these

conditions have little or nothing to do with the prevalence of bloat. While there is always danger from bloat in pasturing alfalfa, it may be cut and fed green as a soiling plant with comparatively little danger. But there are even cases on record where cattle, on the return of appetite after being off feed, have bloated upon alfalfa hay.

DANGER OF OVERPASTURING.

On the other hand an alfalfa field must not be overpastured. As previously stated the plants lack creeping roots or stems by which to spread and can not fill in spots where the alfalfa has died. The close grazing, especially of sheep, and the trampling of large numbers of animals is certain to injure the stand of alfalfa. While the pasturing of alfalfa in the fall may do no harm, it must be remembered that in the warmer portions of the country this season is one of recuperation for the alfalfa plant. If not allowed to make some growth during this period it may not be in condition to start up well the following spring.

PASTURE FOR HOGS, HORSES, AND POULTRY.

Alfalfa is an ideal pasture plant for hogs. There is no danger from bloat and with a limited number of hogs there is practically no injury to the alfalfa field. Vigorous alfalfa will support 15 to 25 head of pigs per acre. It is best to limit the number of pigs to that which will be insufficient to keep down an alfalfa field. Cuttings of hay may then be made at intervals and the growth thus rejuvenated. On the average pigs weighing 30 to 60 pounds in the spring will make a gain of about 100 pounds each during the season. Although pigs may be grown and fattened upon alfalfa alone, it is best to combine the alfalfa with some kind of a grain ration. Alfalfa by itself is too rich in protein to give a balanced ration. Where pigs are pastured upon alfalfa alone they may be prepared for the market by feeding for a few weeks upon corn. It is still better, however, to feed a third to a half of a ration of corn or other grain during the time of pasturing.

In this way pigs may be prepared for the market within a year. By feeding a smaller quantity of grain the time of preparation for market is somewhat extended but the total cost may be less, especially in the warmer portions of the country where alfalfa is available for pasture during a longer period.

The pasturing of hogs may be accomplished by having more than one field into which the hogs may be turned. By pasturing these fields in rotation the alfalfa is given a chance to start and a larger number of hogs may be pastured without injury to the field.

Alfalfa is frequently used as pasture for horses, although the animals should not be confined too closely to this feed. Poultry do well upon alfalfa, and it is recommended that a small patch be available to them in all cases where this crop grows successfully.

ALFALFA FOR SILAGE.

Thus far there has been comparatively little experience in the use of alfalfa as a silage plant. Experiments with this plant have shown, however, that when properly prepared and stored it is valuable for this purpose. It is recommended that green alfalfa be brought immediately to the silo and then passed through a silage cutter. Uncut alfalfa has been placed in the silo, but the results have not been so satisfactory as when the plants have been previously cut in the usual manner. The silage should be well packed and water added, if necessary. In localities where corn can be used as a silage crop there would be no advantage in using alfalfa for this purpose; for, if the conditions are suitable, it is better to use the alfalfa in the form of hay. In humid climates, however, where the curing of alfalfa is attended with difficulty, the crop may be utilized to advantage by placing in the silo. This is especially true of those localities where the first crop of alfalfa is produced during the rainy season of the year. Under such circumstances the first crop may be saved by placing in the silo, while the subsequent crops may be converted into hay. In some regions, especially where there is a winter rainy season, the last crop of alfalfa may be delayed until the weather conditions are unfavorable to curing the hay. If silos are in use the last crop might in such cases be saved as silage.

The value of alfalfa as a silage plant has been tested at the Colorado Experiment Station. It was found that it was necessary in that dry climate to rake up the hay and bring it to the silo immediately after being cut; otherwise it would become too dry. With whole alfalfa the spoiled layer was 3 inches on top and 1 inch on the sides, with a loss of about 10.7 per cent. With alfalfa cut in a silage cutter the spoiled layer was 2 inches on the top and half an inch on the side, with a loss of about 7 per cent.

ALFALFA AS A SOILING PLANT.

Alfalfa cut green and fed partially wilted is one of the best stock feeds available, but in the great alfalfa districts of the United States the crop is rarely utilized for this purpose. It can be so utilized to advantage only where increased labor is compensated by the added value of the alfalfa, as may be true when fed to dairy cattle. In the Eastern States, and especially in the South, alfalfa is commonly used in dairy feeding, for which it is well adapted, since it gives a large yield of very nutritious and palatable forage. There seems to be little or no danger from bloat when alfalfa is used as a soiling crop.

ALFALFA IN A ROTATION.

In common with other legumes alfalfa has the power of gathering nitrogen from the air, as has been explained in a preceding paragraph. On account of this valuable characteristic alfalfa adds fertility to the soil on which it is grown. When the soil upon which alfalfa has been grown is used for other crops the increased fertility is quickly shown by the vigor of these crops. Not only is the soil richer in nitrogen, which would be true in the case of all the legumes, but other mineral constituents are made more available because of the penetrating power of the alfalfa roots. These roots extend to great depth, loosening up the soil and bringing up from below the deeper supplies of the various mineral elements.

In the sugar-beet districts of the West the increased fertility of the soil upon which alfalfa has been grown is shown by the increased yields of sugar beets for at least four years following.

USEFULNESS IN A SHORT ROTATION.

Alfalfa is not ordinarily used in a short rotation in the alfalfa districts. It is, however, well adapted to such a rotation in regions where it can be easily started and where it produces a profitable crop the first year, as it does in the South and the irrigated regions of the West. Even in those parts of the North where late summer sowing is practicable, the crop may be sufficient the next year to justify its use in rotations which permit it to remain down only one or two years. Whether alfalfa should be used instead of clover in short rotations must be determined by the relative yield of the two crops for the first one or two years. Ordinarily where alfalfa can be easily started from fall sowing it will outyield clover the next year, but in much of the clover country alfalfa is as yet too difficult to start to justify any general attempt to substitute it for clover in short rotations.

In the South and West where clover is not grown alfalfa can also be used to advantage in a short rotation wherever the system of rotation employed calls for a leguminous hay crop for two or three years. It may even be practicable to use alfalfa for one year in rotation in parts of the South where it will produce profitable crops when sown in the spring or in the season following fall sowing. While alfalfa is adapted under the favorable conditions mentioned to a short rotation, it may be still better adapted to a longer rotation, when profitable crops may be obtained for a series of years.

A SUGGESTION FOR ALFALFA WITH CORN.

In general, the rotations developed in the clover region have been based on the habits of the clover plant, which ordinarily does not produce profitable crops for more than two years. In sections where

alfalfa becomes thoroughly established, might it not be wise to revise our rotations so that we may better utilize the possibilities of the alfalfa plant? Take, for instance, such a rotation as that suggested by Mr. Joseph E. Wing, from his experience with alfalfa in Ohio: Four years, alfalfa; one year, corn; one year, beardless barley sown with alfalfa. The cultivated crop (corn) gives a chance to destroy weeds, which are apt to get a foothold in the alfalfa field in four years' time. This rotation is entirely practicable, and others based as directly on the habits of alfalfa will, doubtless, in time replace the old clover rotations.

ALFALFA WITH SMALL GRAIN.

The Wyoming Experiment Station demonstrated that irrigated land previously in alfalfa produced $8 to $12 more value in wheat per acre, $16 worth more of oats, and $16 worth more of potatoes than land previously in potatoes or grain, and these gains were made with no cost in fertilizing the land. The alfalfa was not turned under, but had yielded crops of hay for five years.

Mr. David Fairchild[a] states that wheat and alfalfa are successfully grown together at the same time on the dry uplands of North Africa. The alfalfa is planted in rows 3 feet apart, and between the rows a crop of durum wheat is grown every other year.

In the irrigated regions of the western United States grain is occasionally grown in combination with alfalfa, but rather as a supplementary crop. If the stand of alfalfa has been injured, a new seeding of grain and alfalfa may be made in the spring and the mixture of alfalfa and grain hay harvested. It is said that in some regions barley is sown in the fall upon alfalfa fields, thus giving a winter crop of grain, to be followed by the crop of alfalfa upon harvesting the grain.

OTHER USES OF ALFALFA.

Alfalfa has been used as a cover crop in orchards and does very well, although usually other crops are better adapted for this purpose.

Under the system of cultivation used in California, it has been found injurious to the orchards in that State. In dry regions it may rob the trees of needed moisture, especially in young orchards.

As a honey plant alfalfa is to be highly recommended, and in regions where alfalfa is extensively grown the honey produced is well known for its body and richness of flavor.

SEED PRODUCTION.

All the alfalfa seed produced in the United States is now grown in the region lying west of the Missouri River. In the eastern portion

[a] U. S. Dept. Agriculture, Bureau Plant Industry Bul. 72, Part I. Cultivation of Wheat in Permanent Alfalfa Fields.

of the Great Plains region extending from Texas to Nebraska, alfalfa seed is produced without irrigation. The great bulk of the seed, however, is grown by the aid of irrigation in the Arkansas Valley of eastern Colorado and western Kansas, northeastern Colorado, northern Utah, southern Arizona, and the central valleys of California. A limited quantity of alfalfa seed is produced in the Niagara Peninsula of southern Ontario. This seed is used in the Canadian trade. The dry regions of the West provide climatic conditions better adapted to the production of alfalfa seed than do the more humid regions of the Eastern States.

If too much water is supplied to the crop during the time of flowering and ripening of the seed, the strength of the plant goes to foliage rather than to seed. This fact governs the choice of the one of the successive crops to be saved for seed production. Any one of a season's crops may be used for seed providing the conditions are favorable for the ripening and the season is sufficiently long. The time required for the growing of one crop of seed is about equal to that required for the production of two crops of hay. On the whole, the second or third crop is more often cut for seed than the first. This may be because the first crop would mature during a season more humid than that prevailing during the latter part of the year. Except in the southern part of the United States a later crop than the third can not be used because the proper maturing of the seed would be hindered by the advent of cold weather.

HARVESTING FOR SEED.

The best time to cut an alfalfa crop for seed is when about half of the pods have turned brown. It is impossible to obtain all the seed which the plants produce because while the earlier flowers are maturing the new flowers are produced in succession and the seeds from the old flowers are shattered before those from the new flowers mature. The seed crop may be harvested in the same manner as for hay, care being taken to handle the crop in such a manner as to lose as little of the seed as possible by shattering. Many seed growers use a self-binder for harvesting the crop. This is entirely satisfactory except where the alfalfa is badly lodged. When the alfalfa is gathered in this manner it is thrashed from the shock, if practicable. Stacks are made only when thrashing machines are not available at the proper time. Other methods of harvesting find favor in some districts. A mowing machine with a special dropping attachment by which the alfalfa is dropped at intervals has been recommended. When cured the hay can be readily gathered by means of barley forks and thrown on wagons. Much the same result is obtained by the use of a self-rake reaping machine. The hay should be well cured before being

gathered. In the dry regions, the cured hay may be thrashed from the windrow, from bunches, or from the stack, according to convenience. The straw produced from the thrashed alfalfa has considerable feeding value, estimated by those who have used it as being about half that of alfalfa hay, providing the curing was done under favorable conditions. The yield of seed should be from 5 to 7 bushels per acre. In wet seasons the yield may fall much below this; and, under specially favorable circumstances, may rise as high as 11 or 12 bushels per acre. The seed weighs 60 pounds to the bushel. In practice the decision as to whether the crop will be used for hay or saved for seed may depend upon the weather. This is especially true in the less arid regions, where the rainfall is an uncertain factor. If the season is wet and the conditions are such as to produce a large crop of hay, it is much better to use the alfalfa for this purpose. If the reverse conditions are present, the grower may decide to allow the crop to go to seed. In the nonirrigated districts the best seed is likely to be produced upon the drier upland fields where the growth is less vigorous.

FORM AND COLOR, AND ADULTERATION OF SEED.

Alfalfa seeds resemble those of red clover in size, but differ in not being so uniform in shape. The color should be a light olive-green. Darkened, shriveled, and discolored seed should be discarded. On account of the high price of alfalfa seed during the last two or three years a considerable quantity has been imported from Europe. Many samples of the imported seed have been found to be mixed with the seed of dodder, an enemy of alfalfa, which is described in a separate paragraph. The commonest adulterants of alfalfa seed are the seed of yellow trefoil (*Medicago lupulina*) and bur clover (*Medicago maculata* and *M. denticulata*). The plants of yellow trefoil and bur clover are easily distinguished from alfalfa by their smaller size and their yellow flowers. It is not often that home-grown alfalfa seed is adulterated. It sometimes occurs, however, that unadulterated seed is of poor quality, as shown by its brown color as contrasted with the light olive-green of good seed. Such seed should be discarded, as its germination is low.

FEEDING VALUE OF ALFALFA.

It is well known that alfalfa is a highly nutritious and palatable fodder for all classes of farm animals. All kinds of stock eat it greedily, either in the form of green alfalfa or as hay. Below are given tables showing percentage composition, digestibility, and the digestible nutrients in 100 pounds of green alfalfa and alfalfa hay, in each case compared with red clover.

Average percentage composition of alfalfa. [a]

Condition of forage.	Number of analyses.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen free extract.	Ether extract (fat).
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Fresh alfalfa	23	71.8	2.7	4.8	7.4	12.3	1.0
Fresh clover	43	70.8	2.1	4.4	8.1	13.5	1.1
Alfalfa hay	21	8.4	7.4	14.3	25.0	42.7	2.2
Clover hay	38	15.3	6.2	12.3	24.8	38.1	3.3

Average digestibility of alfalfa and red clover, percentage.

(Experiments with ruminants.)

Condition of forage.	Number of analyses.	Protein.	Crude fiber.	Nitrogen free extract.	Ether extract (fat).
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Fresh alfalfa	2	81	45	76	52
Fresh clover	2	67	53	78	65
Alfalfa hay	28	73	43	66	54
Clover hay	46	55	49	69	53

Digestible nutrients in 100 pounds.

Condition of forage.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.		
		Protein.	Carbohydrates.	Ether extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Fresh alfalfa	28.2	3.9	12.7	0.5
Fresh clover	29.2	2.9	14.8	0.7
Alfalfa hay	91.6	10.44	39.6	1.2
Clover hay	84.7	6.8	35.8	1.7

The leaves of alfalfa are richer than the stems in protein, carbohydrates, and fat, but are poorer in crude fiber. The Colorado station has shown that protein in the two cases is 13.12 and 8.61 while the digestible protein is 9.84 and 6.46 parts in 100 parts of dry matter. It is therefore quite essential that alfalfa hay should be put up with as little loss of leaves as possible.

Good, bright alfalfa hay that has not been wet by rains or dew is more valuable for feed than that which has been damaged by water. It has been shown that where good hay contained 18.75 per cent protein in the water-free material, the same hay damaged by rains contained only 11.01 per cent protein.

RELATION TO OTHER FEEDING STUFFS.

Need of grain as a balance.—It will be seen that alfalfa is even more nutritious than clover. On account of its high percentage of protein it is not a balanced ration. For the best results the alfalfa should be combined with some other feed which is rich in carbohydrates. While animals may be fed and even fattened for the

[a] Henry's Feeds and Feeding, Appendix.

market upon alfalfa alone, nevertheless a portion of the nutritive value of the alfalfa is lost in this way. The alfalfa does not give the best results. In order to balance the ration alfalfa should be combined with a suitable quantity of grain. This grain may be corn or barley, according to the availability of each.

Alfalfa as a dairy feed.—As an illustration of feeding alfalfa alone, may be mentioned the case of the dairy farms in the vicinity of Moneta, Cal., where the stock are ordinarily fed no other ration than alfalfa. Since alfalfa is not a balanced ration a number of local dairymen tried to replace a part of the alfalfa by sorghum, thus giving a more nearly balanced ration. The cows, however, did not give as much milk upon this combination as upon pure alfalfa. This result may be assigned to the fact that the cattle were unable to consume a sufficient quantity of the mixture to produce the same results as the alfalfa alone. These dairymen find they can secure a larger milk yield by feeding a little grain; but the increased yield does not pay for the grain, which is high priced in this locality.

EFFECT OF TIME OF CUTTING ON FEEDING VALUE.

The period at which alfalfa is cut has considerable influence on its feeding value. Experiments conducted in the different parts of the country are not in entire accord in regard to this. It has been shown, however, that the amount produced decreases from just before the blooming period until the plant is in full seed; it has also been shown that the first and second crops of hay are richer in protein than succeeding crops. The percentage of protein does not vary much from about the beginning of bloom until the field is one-half in bloom. From a practical standpoint, however, one must take into consideration the total weight of hay, the actual quantity of proteids contained therein, and the digestibility of these proteids at different times. It was thought at the Colorado station that the best time to cut the hay was at the period of full bloom. The Ontario Experiment Station concludes from experiments tried there that alfalfa yields more digestible protein when cut when about one-third in blossom. The consensus of opinion among growers, however, is that alfalfa should be cut when beginning to bloom. The total amount of nutritive material obtained at one cutting may be somewhat less, but the cuttings can be made more frequently, so that the yield of the entire season is greater. Experiments at the Central Station, Ottawa, Canada, show that more fodder and a larger amount of nutritive material was obtained by making four cuttings during the season than by making two.

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EXPERIMENTS IN FEEDING ALFALFA.

Pigs in Nebraska.—Pig-feeding experiments carried on at the Nebraska Experiment Station with corn and alfalfa hay showed that the cheapest gains were made by means of corn and chopped alfalfa. In this combination the greatest gains were made where the ration was three-fourths corn and one-fourth alfalfa, but where the alfalfa was raised on the farm and there was no particular need of hastening the growth of the pigs, it was found that cheaper gains were made with one-half alfalfa and one-half corn.

Cattle and hogs in Kansas.—At the Kansas Experiment Station cattle fed upon a ration of corn and alfalfa hay gained much more than others fed upon other rations. During the one hundred and fifty-three days of the test the value of the gains made by the different lots were: Corn and alfalfa hay, $109.74; barley and alfalfa, $57.16; wheat and alfalfa, $44.91; corn and sorghum, $27.09; corn and prairie hay, $56.96; corn and oat straw, $43.28. At the same station hogs were fed on a ration of alfalfa hay and Kafir corn meal. The gains were 73 per cent more on this ration than upon a ration of Kafir corn meal alone. For every bushel of Kafir corn meal and 7.83 pounds of alfalfa hay the gain was 10.88 pounds, while upon Kafir corn meal alone the gain was 7.48 pounds per bushel. It is shown that the hay gave better results when cut early and that the chief nutriment was in the leaves, which should be carefully saved during the process of harvesting. An earlier experiment at the same station was tried to determine the value of alfalfa pasture for hogs. The hogs were allowed to run upon the alfalfa during the summer and were fed a light ration of grain. After deducting the probable gain for the corn it was found that during the summer each acre of alfalfa pasture produced 776 pounds of pork.

Steers in Utah.—At the Utah Experiment Station steers made a most rapid gain when fed upon early-cut alfalfa either with or without an accompanying ration of grain. By early-cut hay was meant hay cut just before bloom. The gain upon this early cut alfalfa hay was one-third more than that upon hay cut when in full bloom or later. It was also found that more hay was produced from the early cuttings and that the third crop gave more rapid gains than either the first or second, which latter are nearly equal in this respect.

Substitute for bran, etc.—The New Jersey Experiment Stations[a] recommend feeding alfalfa hay in the Eastern States as a substitute for the concentrates usually fed in dairies there, such as bran, cotton-seed meal, and dried brewers' grains. A satisfactory combination was 36 pounds of soy-bean silage, 8 pounds of alfalfa hay, and 6 pounds of corn meal. The advantage of this ration is that all the constituents

[a] N. J. Expt. Stas. Bul. 148, Feb., 1901.

can be grown upon the farm. The soy beans were cut just as the pods were forming, run through a silage cutter, and placed in the silo without mixing with any other crop. A five-year test with alfalfa demonstrated that an average yield of about 20 tons per acre of green forage could be obtained, which is equivalent to about 5 tons of hay, which was produced at a cost of $5.50 per ton. It is interesting to note that this ration not only cost less but was a greater milk producer than the one with which it was compared—36 pounds of corn silage, 4 pounds of wheat bran, 4 pounds of dried brewers' grains, and 2 pounds of cotton-seed meal. At the same station a comparison was made between a ration containing 35 pounds of corn silage, 11 pounds of alfalfa hay, 6 pounds of mixed hay, 2 pounds of cotton-seed meal, and the same ration in which the alfalfa hay was replaced by 4 pounds of wheat bran and 4 pounds of dried brewers' grains. The two rations contain the same amount of protein. The conclusion was that alfalfa hay could be substituted for the two concentrates, and was worth $11.16 per ton as compared with wheat bran and dried brewers' grains costing $17 per ton. In general, alfalfa hay may be substituted for bran at the rate of about 1½ pounds of hay to 1 of bran. For the best results the hay should be chopped fine.

From experiments conducted at the Tennessee Experiment Station, it was shown that alfalfa or cowpea hay could be produced at a cost of $3 to $5 per ton and could be substituted for wheat bran which cost $20 to $25 per ton. Alfalfa hay can not be substituted entirely for cotton-seed meal as the latter is so very rich in protein. It was calculated that with alfalfa hay at $10 and wheat bran at $20, the saving effected by substituting alfalfa hay for wheat bran would be $2.80 for every 100 pounds of butter, and 19.8 cents for every 100 pounds of milk.

PREPARED FEEDS CONTAINING ALFALFA.

On account of the value of chopped alfalfa hay for stock feed a preparation has been placed upon the market which is intended to take the place of the alfalfa hay. This preparation of ground alfalfa hay is known as alfalfa meal. At present this alfalfa meal is made in Nebraska and California. One of these preparations is said to consist of a mixture of alfalfa meal and sugar-beet molasses. Such preparations, if made from the best quality of alfalfa hay, are convenient for feeding, especially when they take the place of ordinary concentrates. A somewhat greater percentage of the hay is utilized by animals when finely ground than when fed in the form of hay. Circumstances must determine whether this is the most economical method of feeding the alfalfa. Transportation charges on alfalfa meal are less than on alfalfa hay, for which reason it may compete seriously with alfalfa hay in regions remote from alfalfa centers.

ALFALFA FOR HORSES.

There is no doubt that alfalfa is an excellent forage plant for horses, both as pasture and as hay. Horses do well upon alfalfa pasture, but care must be exercised that they do not injure the stand of alfalfa by trampling or by too close grazing. In the alfalfa regions of the West work horses upon the farm may be fed the year round upon no other ration than alfalfa. It is, however, generally conceded that horses, while heavily worked, should receive at least a small grain ration in order to produce the maximum effect. This is especially true of livery horses and those which are worked upon the road. On the other hand there is a prejudice against alfalfa as feed for horses which is due largely to unfamiliarity with this kind of hay. Horses as well as other animals may not take alfalfa hay readily until they have acquired a taste for it. It has also been found that injurious effects may follow a sudden change to alfalfa hay from some other kind of feed. This seems to be due to the large proportion of protein which may overstimulate the animal. There are also certain other reasons why alfalfa is objected to by horse men. The manure is softer and more liquid than that from animals fed upon timothy hay, and it is more difficult to keep the animals and the stables clean. It is a fact, however, that the use of alfalfa hay for horses is rapidly increasing.

ENEMIES OF ALFALFA.

WEEDS.

One of the most important factors in hindering the development of alfalfa on soil suited to its growth is the presence of weeds. This is especially true in the more humid regions, and in the Southern States it seems to be the usual cause of failure on soils sufficiently fertile to support alfalfa. Alfalfa is quite tender when it first comes up and the young plants are easily crowded out by weeds. The weeds may appear about the same time as the alfalfa and thus prevent the latter from obtaining a start. Alfalfa sown in the spring is especially vulnerable, for which reason it is advisable to sow in the late summer or early fall, and to sow upon land which has been freed from weeds by previous cropping, tillage, or summer fallow. If the conditions are favorable for the growth of alfalfa, a weedy field may often be saved by frequent clipping with a mowing machine. In the sandy soils of the Southern States fall sowing, as described, may produce a good stand and one good cutting may be obtained the following spring, after which crab grass or other noxious weeds suddenly spring up and the alfalfa is immediately choked. If the weeds are not too numerous, clipping with a mowing machine may save such a field. Harrowing may also destroy some kinds of weeds, particularly crab grass. Old alfalfa

fields may also suffer from weeds. This is usually due to the killing of the alfalfa in spots from some unfavorable condition, the ground then being taken by an aggressive weed. In the irrigated regions such bare spots may be caused by water standing too long or by the tramping of animals pastured upon the field.

The Georgia Experiment Station recommends planting the seed in rows sufficiently far apart to allow of horse cultivation. Good results have been obtained upon the station farm, and the method is frequently used upon a small scale in many parts of the South. Cultivation between the rows will keep down the weeds until the alfalfa is well established, after which one or two cultivations between cuttings will be sufficient for this purpose. This method increases the expense, but since in this region hay from legumes is high priced, the returns seem to warrant the extra expense. Rolling or disking aids in preventing the old crowns from protruding too far above the surface.

Squirrel-tail and similar grasses.—Squirrel-tail grass (*Hordeum jubatum*), also called foxtail in Wyoming, barley grass in Utah, and tickle grass in Nevada, is a common weed in the Great Basin region; and another species (*Hordeum murinum*), called wild barley, barley grass, and foxtail, is common on the Pacific slope. The common dandelion is troublesome in parts of Utah and Idaho. In the limestone regions of the Northeastern States bluegrass encroaches seriously upon alfalfa fields. Old fields that become weedy are often benefited by disking in the spring and after the cuttings are made. Alfalfa has no method of propagation by creeping roots or stems and consequently the plants do not spread, but the disking kills the weeds and splits the crowns of some of the alfalfa plants vertically, rejuvenating them. Seed sown upon the vacant areas at such a time may improve the stand. Where the weeds succeed in obtaining the upper hand it is best to plow up the field and reseed it.

Johnson grass.—In many parts of the Southern States, especially the prairie region from northern Texas to central Alabama, Johnson grass is a pernicious weed. In those portions of this region where alfalfa is a successful forage plant it has been found that when established upon Johnson grass land the alfalfa will smother out the Johnson grass, or at least hold its own by its side. Even though the alfalfa does not entirely kill out the Johnson grass, and there is consequently a mixture of the two plants, they form a very nutritious combination and in Johnson grass regions this is one of the best methods by which fields infected by this weed may be utilized.

If it is desired to establish alfalfa upon black land in Texas badly infested with Johnson grass, the ground should be plowed in the fall, September or October, harrowed to remove the roots of the Johnson

grass as much as possible, and then sown to alfalfa. The alfalfa starts much more readily than the Johnson grass during the cool weather of fall and winter. The following season the field should be mowed often enough to prevent the Johnson grass from getting ahead of the alfalfa. Since alfalfa recovers from cutting more quickly and will produce more crops than the Johnson grass, the latter is so much weakened and smothered that there is usually no trouble from this during the second or subsequent seasons.

FIG. 7.—Dodder plant on an alfalfa stem.

FUNGI.

The most important fungous disease of alfalfa is that known as rust, a spot disease caused by *Pseudopeziza medicaginis*. The plants turn yellow and show minute black spots upon the leaves. Mowing an infected field will usually overcome the disease by producing a vigorous growth.

In certain parts of the South, notably in Texas, alfalfa suffers from root rot, a disease affecting cotton in those localities. This disease is indicated by the whole plant turning brown and dying. The disease lives in the soil and occurs in well-marked areas. There is no cure, and the only preventive is to plant alfalfa on soil free from the disease.

FIG. 8.—Dodder seed (*Cuscuta epithymum*).

DODDER.

This is an orange-yellow thread-like vine which grows as a parasite upon the alfalfa plants (fig. 7). The seeds of the dodder are somewhat smaller than the alfalfa seeds (fig. 8), but are not separated from them except by careful recleaning; consequently, they are often sown along with

the alfalfa seed, especially in that which has been imported. If a field is badly infested it should be plowed up and devoted to some other crop for a few years. Small infested patches should be carefully removed by hand, or the patches should be burned by scattering straw or hay over them and setting fire. The dodder plant has no roots in the soil and conseqently can be removed by cutting the alfalfa plant close to the ground. There are several other species of dodder or lovevine occurring on other plants, but none of these will ordinarily attack alfalfa. It should be known that alfalfa seed intended for sowing is free from dodder seed, as it is much easier to prevent the introduction of such a weed than it is to remove it afterwards. Dodder seed is somewhat smaller than alfalfa seed, is more angled, and is not curved nor bean-like in shape.

ANIMALS.

In the Western States certain burrowing animals, such as pocket gophers, prairie dogs, ground squirrels, and field mice, are sometimes troublesome in alfalfa fields. These can be poisoned by grain soaked in strychnine or by pieces of fresh potatoes inclosing a small grain of strychnine placed in their runs. They may be drowned out with water or attacked with carbon bisulphid in their burrows. Rabbits often forage upon alfalfa fields, but they do little damage except upon small patches. Experimental plots near dwellings are likely to be annihilated by poultry. Grasshoppers do much damage in the Plains region. In some localities the alfalfa worm, which eats the leaves and spins a web upon the plants, destroys a portion of the crop. Mowing an infected field seems to check its depredations.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.:

No. 16. Leguminous Plants. No. 22. The Feeding of Farm Animals. No. 24. Hog Cholera and Swine Plague. No. 25. Peanuts: Culture and Uses. No. 27. Flax for Seed and Fiber. No. 28. Weeds: And How to Kill Them. No. 29. Souring and Other Changes in Milk. No. 30. Grape Diseases on the Pacific Coast. No. 31. Alfalfa, or Lucern. No. 32. Silos and Silage. No. 33. Peach Growing for Market. No. 34. Meats: Composition and Cooking. No. 35. Potato Culture. No. 36. Cotton Seed and Its Products. No. 37. Kafir Corn: Culture and Uses. No. 38. Spraying for Fruit Diseases. No. 39. Onion Culture. No. 41. Fowls: Care and Feeding. No. 42. Facts About Milk. No. 43. Sewage Disposal on the Farm. No. 44. Commercial Fertilizers. No. 45. Insects Injurious to Stored Grain. No. 46. Irrigation in Humid Climates. No. 47. Insects Affecting the Cotton Plant. No. 48. The Manuring of Cotton. No. 49. Sheep Feeding. No. 50. Sorghum as a Forage Crop. No. 51. Standard Varieties of Chickens. No. 52. The Sugar Beet. No. 54. Some Common Birds. No. 55. The Dairy Herd. No. 56. Experiment Station Work—I. No. 57. Butter Making on the Farm. No. 58. The Soy Bean as a Forage Crop. No. 59. Bee Keeping. No. 60. Methods of Curing Tobacco. No. 61. Asparagus Culture. No. 62. Marketing Farm Produce. No. 63. Care of Milk on the Farm. No. 64. Ducks and Geese. No. 65. Experiment Station Work—II. No. 66. Meadows and Pastures. No. 68. The Black Rot of the Cabbage. No. 69. Experiment Station Work—III. No. 70. Insect Enemies of the Grape. No. 71. Essentials in Beef Production. No. 72. Cattle Ranges of the Southwest. No. 73. Experiment Station Work—IV. No. 74. Milk as Food. No. 75. The Grain Smuts. No. 77. The Liming of Soils. No. 78. Experiment Station Work—V. No. 79. Experiment Station Work—VI. No. 80. The Peach Twig-borer. No. 81. Corn Culture in the South. No. 82. The Culture of Tobacco. No. 83. Tobacco Soils. No. 84. Experiment Station Work—VII. No. 85. Fish as Food. No. 86. Thirty Poisonous Plants. No. 87. Experiment Station Work—VIII. No. 88. Alkali Lands. No. 89. Cowpeas. No. 91. Potato Diseases and Treatment. No 92. Experiment Station Work—IX. No. 93. Sugar as Food. No. 94. The Vegetable Garden. No. 95. Good Roads for Farmers. No. 96. Raising Sheep for Mutton. No. 97. Experiment Station Work—X. No. 98. Suggestions to Southern Farmers. No. 99. Insect Enemies of Shade Trees. No. 100. Hog Raising in the South. No. 101. Millets. No. 102. Southern Forage Plants. No. 103. Experiment Station Work—XI. No. 104. Notes on Frost. No. 105. Experiment Station Work—XII. No. 106. Breeds of Dairy Cattle. No. 107. Experiment Station Work—XIII. No. 108. Saltbushes. No. 109. Farmers' Reading Courses. No. 110. Rice Culture in the United States. No. 111. Farmer's Interest in Good Seed. No. 112. Bread and Bread Making. No. 113. The Apple and How to Grow It. No. 114. Experiment Station Work—XIV. No. 115. Hop Culture in California. No. 116. Irrigation in Fruit Growing. No. 118. Grape Growing in the South. No. 119. Experiment Station Work—XV. No. 120. Insects Affecting Tobacco. No. 121. Beans, Peas, and other Legumes as Food. No. 122. Experiment Station Work—XVI. No. 123. Red Clover Seed: Information for Purchasers. No. 124. Experiment Station Work—XVII. No. 125. Protection of Food Products from Injurious Temperatures. No. 126. Practical Suggestions for Farm Buildings. No. 127. Important Insecticides. No. 128. Eggs and Their Uses as Food. No. 129. Sweet Potatoes. No. 131. Household Tests for Detection of Oleomargarine and Renovated Butter. No. 132. Insect Enemies of Growing Wheat. No. 133. Experiment Station Work—XVIII. No. 134. Tree Planting in Rural School Grounds. No. 135. Sorghum Sirup Manufacture. No. 136. Earth Roads. No. 137. The Angora Goat. No. 138. Irrigation in Field and Garden. No. 139. Emmer: A Grain for the Semi-arid Regions. No. 140. Pineapple Growing. No. 141. Poultry Raising on the Farm. No. 142. Principles of Nutrition and Nutritive Value of Food. No. 143. 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